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The Influence of Technology on the Theory of Warfare:

Clausewitz revises On War After the Battle of Britain

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The Influence of Technology on the Theory of Warfare:
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"...in modern war one will search in vain for a battle in which the winning side triumphed over an army twice its size."

Carl Von Clausewitz

Yet, throughout the summer and early fall of 1940, the Royal Air Force fought the Battle of Britain against a German Luftwaffe that enjoyed at least a four-to-one numerical advantage. The bravery of the RAF pilot notwithstanding, the battle was decided in favor of the British by technological innovations that evened the odds.

Did the technological revolution that followed Clausewitz's death in 1830 render On War obsolete? Or had he anticipated the future when he said, "...what it usually comes down to is that one side invents improvements and first puts them to use, and the other side simply copies them," thereby validating his theory against time and change?

Citing the exploitation of the electromagnetic spectrum during the Battle of Britain, this paper examines the impact of technology on Clausewitz's theory of warfare. It specifically examines how the use of radar, signals intelligence, and electronic counter measures affect his concepts of numerical superiority, relative strength, and night operations. To systematically examine each area, I will discuss a thesis (Clausewitzian concept), antithesis (technological innovation), and synthesis (Clausewitz's rewrite). In addition, I'll project that synthesis onto tomorrow's electronic battlefield. The framework I'll use is outlined below.

Framework for examining Clausewitzian principles within the context of technological innovation			
THESIS Clausewitz's Concept	ANTITHESIS Technological Innovation	SYNTHESIS	PROJECTION Tomorrow's Battlefield

Before applying the framework to Clausewitz and technology, I will briefly discuss the Battle of Britain in terms of the electromagnetic spectrum.

THE BATTLE OF BRITAIN, JULY THROUGH SEPTEMBER, 1940.

Having stormed through the European land mass, Hitler paused in June, 1940, to consider his next move. While he did not want to repeat Germany's World War One mistake of fighting a simultaneous two-front war, he also did not want to invade Britain at this time. He needed, however, to keep Britain from opening a Western front against him. Therefore, he approved the Luftwaffe's "Eagle Attack" plan to destroy the RAF and hold the Royal Navy at bay in preparation for "Sea Lion," the actual invasion of Britain. Hitler hoped that "Eagle Attack" would also destroy the British will to fight, rendering an invasion unnecessary. Although there are varying accounts of the strengths of the RAF and Luftwaffe, some going as high as a six-to-one ratio in favor of the Germans¹, Hitler knew that he enjoyed a considerable advantage in numbers of fighters and bombers over the RAF fighters.²

The British, however, held a closely guarded trump card. Starting with the British government's request to Sir Robert Watson-Watt in the 1930s to explore the possibilities of an electronic "death ray," the scientific and military communities built an extraordinarily close working relationship. While Sir Watson-Watt and his scientific colleagues were unsuccessful in finding a

directed energy weapon, the military-scientist relationship produced several ways to exploit the electromagnetic spectrum. They established a command and control structure based on radar early warning and controller directed intercepts, created the "Y Service" to intercept and exploit German radio transmissions, and (after the battle had begun) discovered a counter to the German precision radio bombing system.

Still, victory was a near thing. The Luftwaffe's objective to destroy the RAF nearly succeeded at the end of August, when Hitler -- annoyed by the British bombing of Germany -- released them to begin the terror bombing of British cities. This gave the RAF time to repair airfields and aircraft. They became increasingly successful at turning back Luftwaffe raids, and in mid September 1940, Hitler gave up on "Sea Lion." Although aerial fighting over England continued throughout the war, the RAF in effect won the Battle of Britain on 15 September 1940, something few British (or Americans -- Joseph Kennedy returned to America after the first month of the battle and declared that Great Britain was through) believed could happen.

Having viewed the battle, I will now discuss the effects of technology on the Clausewitzian concepts of numerical superiority, relative strength, and night operations, as well as implications for the future.

PRINCIPLE: SUPERIORITY OF NUMBERS.

THESIS. Clausewitz wrote that numerical superiority is the most common element in victory.³ Strategically, he postulated that even the most talented commander would find it very difficult to defeat an enemy twice his size. Tactically, Clausewitz addressed *relative* strength, stating that the commander must employ his forces to gain relative superiority at the decisive point during

the engagement. He acknowledged that there were other factors influencing the outcome of the engagement, but if all these variables were stripped away, numbers would determine victory. In addition, he wrote that the commander must be able to correctly calculate both time and space in order to properly judge the decisive point.

ANTITHESIS. The RAF won the Battle of Britain by overcoming an enemy that was well more than twice their strength. They were able to exploit the electromagnetic spectrum via a command and control system consisting of radar operators who detected incoming raids; operations center plotters who fused inputs from several radar sites into a coherent, timely air picture; and controllers who scrambled fighters and vectored them to their targets based on air picture information. With this system, the RAF predicted incoming raid paths and formation strength; scrambled appropriate numbers of interceptors and tactically positioned them for the riposte; and then continuously tracked the raid and reallocated fresh interceptors as they became available. The command and control system allowed the RAF more efficient use of their limited number of aircraft; radar became a force multiplier. As evidence, the week of 13 September found the RAF with only 47 Spitfires and 80 Hurricanes serviceable, yet Luftwaffe air crews continued to report "large formations [of fighters] rising to meet them" at every raid. ⁴

SYNTHESIS. Despite the impact of technology on the numerically inferior RAF's defeat of the Luftwaffe, Clausewitz would continue to stress the concept of both tactical and strategic superiority of numbers.

Tactically, the command and control system gave the RAF the ability to mass fighters at the decisive point to achieve Clausewitz's goal of relative superiority. Numerical advantage was no less important "at the merge" in 1940 than in land warfare in 1840: more is always better.

Strategically, Clausewitz would continue to stress the importance of superiority of numbers: "the first rule...put the largest possible army into the field." However, he would put less emphasis on his hard and fast two-to-one numerical superiority as an insurer of victory, "however adverse the other circumstances." The RAF's command and control system (the other circumstance) allowed the fighter controller to understand and counter the enemy's plan of attack before the enemy reached his decisive point. In other words, command and control put the RAF inside the Luftwaffe's decision cycle. Without their command and control system, the RAF would have had two choices: maintain constant and numerous combat air patrols to detect incoming raids, placing tremendous stress on both man and machine; or react to raids once they were visually detected approaching their coastline, sacrificing the advantage of being inside the Luftwaffe decision cycle. Clausewitz would revise upward what he considered the significant superiority in numbers to be in light of the effect of technology during the Battle of Britain.

Technology not only allowed the RAF to get inside the Luftwaffe's decision cycle, but also gave the RAF the ability to take advantage of the faster decision cycle time. The exploitation of the electromagnetic spectrum radically altered the time and space dimension of Clausewitz's battlefield in terms of the command and control of forces. Clausewitz would have added a book to On War discussing the impact that command and control now had on both strategic and tactical warfighting.

PROJECTION. On the next electronic battlefield, getting inside the enemy's decision cycle and having a responsive command and control capability to exploit that advantage will be more difficult and more critical. Today, the entire detection to destruction cycle is only six to ten minutes, ensuring a "speedy death for incompetent or unlucky soldiers." Linking sensors to shooters will

create a battlefield where the side that detects and attacks first, wins.⁵ As the Marine Corps' manual Warfighting states, "whoever can make and implement his decisions consistently faster gains a tremendous, often decisive advantage." The key for the electronic battlefield of the future is to develop faster command and control processes that allow us to get inside the enemy's decision cycle and cutoff their opportunities for action.

PRINCIPLE: RELATIVE SUPERIORITY.

THESIS. Clausewitz devoted Chapter Three of Book Five to the importance of relative strength, and in it he emphasized the equality of armies.⁶ He stated that there was little difference between the best and worst armies; that when one army used an improvement, the other side quickly copied it and both sides were again equal. As a result, efforts by generals to gain advantages such as superior organization and equipment had declined. He summarized by stating that such decline served to increase the importance relative strength.

ANTITHESIS. Germany was well ahead of the Allied powers in radar development prior to the start of World War Two. However, they viewed radar as a defensive weapon and put the development on hold, since they were planning and equipping for the offense. As a result, the British passed them technologically with the development of the cavity magnetron, allowing for a significantly smaller bandwidth radar.⁷

SYNTHESIS. Clausewitz correctly understood how relatively narrow the window of technological advantage was, but he misjudged the potential significance and impact of technology on the battlefield. After the Battle of Britain in which the RAF was able to exploit technology with such success, Clausewitz would have rewritten the chapter to stress that armies must continually strive to develop and apply new technology rather than accepting

that the opposing side would soon catch up and be equal. He would make two points: armies must not overlook the advantage technology can give them just because it may be short lived; and they must continue searching for ways to exploit technology in order to gain technological advantages.

PROJECTION. Technology will continue to have a major impact on tomorrow's electronic battlefield. For example, today we have intelligence sensors that produce so much data that analysts can evaluate less than 10 percent of it -- totally inadequate for war.⁸ To exploit that technology, we must develop the means to meet the needs of tomorrow's warrior. Having found the means, we must then search for the next technological advantage as the opposition closes the window of advantage. Warfighting states it best, "the belligerent who first exploits a development...gains a significant, if not decisive, advantage."

PRINCIPLE: NIGHT OPERATIONS.

THESIS. Clausewitz wrote that night operations were a matter of tactics and that it was an intensified raid.⁹ While the attacker seemingly had the advantage of surprise, confusion, and preparedness, night operations assumed that the attacker had complete knowledge of the defender's layout and disposition of forces. This complete knowledge was difficult to obtain, therefore attacks on large forces were extremely difficult and under ordinary circumstances not to be used. The attacker needed his eyes for night operations, therefore special reasons were needed to justify a night attack.

SYNTHESIS. Throughout the summer of 1940 a second Battle of Britain was being carried out between Luftwaffe night bombers and the scientists of Britain.¹⁰ The Germans had perfected "Knickenbein" (British codename "headache"), a radio beam transmitted from German occupied France that was about 450 yards

wide. This beam consisted of a continuous tone center beam and side beams of dots and dashes (dots on the right, dashes to the left). The Luftwaffe bomber crew would steer on the continuous tone enter beam, correcting left or right when they heard dots or dashes, until they passed a second intersecting beam that keyed the bombardier to release his weapons. The Luftwaffe developed and tested Knickebein during the summer of 1940. Fortunately for the alert British, they detected the Headache in June.

A secret British unit simply known as the Y Service, or Listening Service, had found a mysterious German radio signal which they labeled Headache. Correlating its presence with Luftwaffe bomber activity, they surmised its purpose and countered it with "Aspirin." An Aspirin consisted of electro-diathermy equipment borrowed from hospitals that transmitted dashes on the same wavelengths as Headache, serving to confuse the Luftwaffe bomber crews. In addition, the RAF established five night fighter squadrons, using Blenheim airframes outfitted with narrow bandwidth radars.

The Luftwaffe's first night bombing effort began on 28 August and lasted for four nights, with over 150 bombers delivering their deadly loads on the docks of Liverpool. The Blenheim night fighters were unsuccessful, as only one fighter got a contact on a bomber but was too slow to catch and engage it. Aspirin was more effective: Luftwaffe pilots talked of bombers that had flown in circles until the crews were dizzy, and at least one Heinkel crew landed on the beach near Bridport, England, so confused that they thought they had arrived at their own local airfield guidance beam and landed at home base. Overall, the Luftwaffe's first effort was successful, and they continued them.

SYNTHESIS. Technology had brought night fighting into modern warfare. Even as they were using Knickebein in August, the Luftwaffe was equipping its bombers with "X-Gerat," an even more sophisticated precision bombing system.

And although none of the Blenheims were successful during the week of 28 August 1940, the RAF continued to refine its night intercept capability. With electronic eyes, the night fighter no longer had to take extreme risks, night attacks no longer had to be limited, and night operations left the realm of mere tactics. Correspondingly, Clausewitz would significantly alter his concept of night operations.

For the British, disrupting the enemy's use of the electromagnetic spectrum by electronic counter measures was more successful than employing the Blenheims during the week of 28 August. This was an indirect approach to warfighting that would have caused Clausewitz pause. If one could prevent the enemy from reaching his objective by electronic means, could one defeat the enemy without engaging him? Would Clausewitz entertain thoughts of an indirect approach? No. Clausewitz would maintain that fighting continues to be the central military act and that disrupting the electromagnetic spectrum supported that act. However, to his new book on command and control he would add a chapter on disrupting the enemy's use of the spectrum, as well as a chapter on protecting one's own access to it.

PROJECTION. As the development of the electromagnetic spectrum continues in order to give us better command and control capabilities, the protection and disruption of that spectrum becomes significant. The Soviet Army had a concept of "critical time," defined as the specific period of time in which a mission could be successful. Action outside that window would significantly increase the probability of mission failure.¹¹ As Colonel General Grinkevich of the former Soviet Army wrote, "...time has taken on a material quality and has been transformed into one of the decisive factors of combat force...to forestall the enemy...is to beat him, and to delay is to suffer defeat." The Soviet concept of disrupting the enemy's spectrum in order to delay him, while protecting one's

own access in order not to be delayed, will take on a significant dimension on the next electromagnetic battlefield.

CONCLUSION.

This paper examined the impact of technology on Clausewitz's theory of warfare by citing examples of exploitation of the electromagnetic spectrum during the Battle of Britain. It specifically examined how the use of radar, signals intelligence, and electronic counter measures affected Clausewitz's concepts of numerical superiority, relative strength, and night operations. In addition, it projected the results onto tomorrow's electronic battlefield.

The Marine's Warfighting states that war is "both timeless and ever changing." Similarly, Clausewitz's writings were both timeless yet subject to change as well. His theory was based on war as he experienced it, and his predominant theme was that fighting was the central military act and all other activities merely supported it. The ability to exploit the electromagnetic spectrum, as seen during the Battle of Britain, took the battlefield beyond visual range; and that exploitation represented a qualitative change in the way warfighting was supported. Therefore, Clausewitz would rewrite On War to include the exploitation of the electromagnetic spectrum as it supports warfighting. But he would not change his dominant theme of fighting until a qualitative change occurred in warfighting itself.

Notes

¹ Jack Nissen and A.W. Cockerill, Winning the Radar War (New York: St. Martin's Press, 1987) 80.

² Len Deighton, Fighter, The True Story of the Battle of Britain (New York: Knopf, 1978) 122.

³ Carl Von Clausewitz, On War, ed. and trans. Michael Howard and Peter Paret (New Jersey: Princeton University Press, 1976) 194-197.

⁴ Deighton 215.

⁵ Bill Munro, The Quick and the Dead (New York: St. Martin's Press, 1991) 189.

⁶ Clausewitz 282-284.

⁷ Deighton 84-93.

⁸ Munro 145.

⁹ Clausewitz 273-275.

¹⁰ Deighton 189-193.

¹¹ Munro 176.